

ENVIRONMENTAL PROGRAM INFORMATION

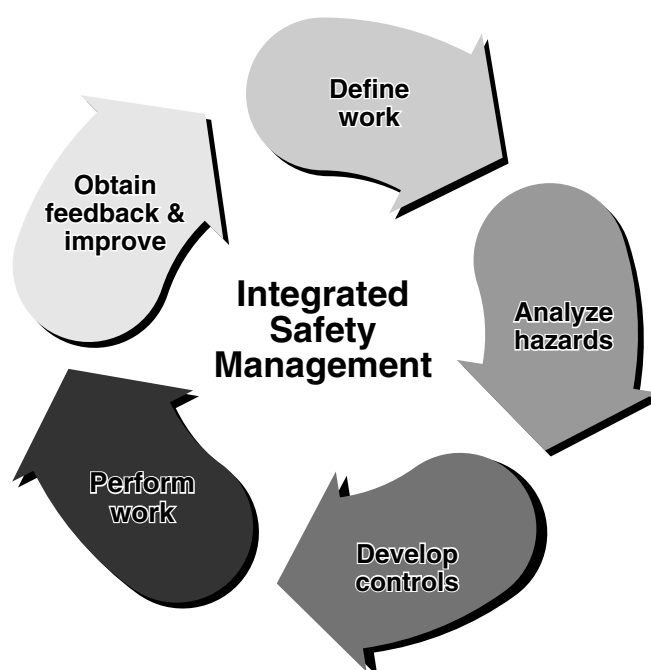
Introduction

Lawrence Livermore National Laboratory is committed to operating in a manner that preserves the quality of the environment. The Environmental Protection Department (EPD) leads this effort in the areas of environmental compliance and accountability. This chapter begins with a brief description of LLNL's integrated Environment, Safety, and Health (ES&H) Management System Work Smart Standards (WSS), and the missions and activities of EPD and its three divisions. Performance measures (PMs) used by the U.S. Department of Energy (DOE) to evaluate the Laboratory's environmental protection efforts are then summarized. The bulk of the chapter is devoted to an account of LLNL's activities and progress in waste minimization and pollution prevention in 2000. Following descriptions of current issues and actions in the environmental program arena, this chapter concludes with a brief discussion of spill response.

Integrated Environment, Safety, and Health Management System

In accordance with the requirements of the University of California's (UC's) Prime Contract W-7405-ENG-48, Clause 6.7, LLNL has implemented an Integrated Safety Management System

(ISMS). The LLNL ISMS is designed to ensure the systematic integration of ES&H considerations into management and work practices so that missions are accomplished safely. "Safety" used in this context is synonymous with environment, safety, and health to encompass protection of the public, workers, and the environment (including pollution prevention and waste minimization). The core requirements of ISMS are based on the DOE's Seven Guiding Principles and Five Core Functions.





The Seven Guiding Principles can be summarized as: (1) line management is responsible for ensuring the protection of employees, the public, and the environment; (2) clear roles and responsibilities for ES&H are established and maintained; (3) personnel competence is commensurate with their responsibilities; (4) resources are effectively allocated to address ES&H, programmatic, and operational considerations with balanced priorities; (5) safety standards and requirements are established that ensure adequate protection of the employees, the public, and the environment; (6) administrative and engineering controls to prevent and mitigate ES&H hazards are tailored to the work being performed; and (7) operations are authorized.

The Five Core Functions that describe how LLNL manages and performs work are summarized as: (1) define the scope of work; (2) identify and analyze the hazards associated with the work; (3) develop and implement hazards controls; (4) perform work within the controls; and (5) provide feedback on the adequacy of the controls for continuous improvement.

The implementation of a management system based on these principles and functions results in accountability at all levels of the organization, project planning with protection in mind, and excellence in program execution. The ISMS Program at LLNL employs a process of assessing hazards and the environmental implications of work; designing and implementing standards-based methods intended to control risks; and complying with applicable ES&H requirements. This process is implemented using a graded approach, which increases the level of risk management as hazards increase. The complete description of LLNL's ISMS can be found in *Integrated Safety Management System Description* (Clough 2000).

DOE initiated a verification review of LLNL's implementation of ISMS on November 29, 1999, and the results of the verification were presented on December 9, 1999. DOE recommended approval of the LLNL ISMS description after the completion of several action items.

Work Smart Standards

Work Smart Standards (WSS) are an integral part of an ISMS, whereby safety professionals identify ES&H hazards and establish standards of operation appropriate for the particular work environment.

The WSS process requires an understanding of the work, an analysis of the hazards associated with the work, and the selection of standards from which hazard controls are developed. This process empowers the Laboratory and local DOE staffs, through consensus, to focus on the work being performed and to select sitewide ES&H standards based on the actual work being conducted and its associated hazards and threats to the environment.

WSS were approved at the management level closest to and with the most expertise in the work. The LLNL Director and DOE/OAK Manager approved the final set of sitewide standards on August 5, 1999, after they were confirmed by an independent panel of external experts in March 1999. The WSS set was essentially considered part of the UC contract once it was signed by the LLNL Director and the DOE/OAK Manager. Reaching these agreements with DOE on new work-based standards aligns the Laboratory with industry practice, establishes common ES&H expectations for DOE and UC, and facilitates the tailoring of requirements to streamline and increase the effectiveness of management at the Laboratory. LLNL's existing ES&H methodologies and documentation have been modified to incorporate the newly identified set of standards and to reflect the requirements of ISMS.

The WSS set currently identified to satisfy the ES&H needs of the LLNL work environment are in the UC contract, Appendix G and can be viewed at: <http://labs.ucop.edu/internet/wss/wss.html>. The DOE orders applicable to the environment that are included in the WSS are listed in Appendix B of this report.

Meeting new expectations for integrated ES&H management at the Laboratory will take several years, but the WSS approach, coupled with enhanced, integrated management, promises further safety improvements and lower costs.

Environmental Protection Department

As the lead organization at LLNL for providing environmental expertise and guidance on operations at LLNL, EPD is responsible for environmental monitoring, environmental regulatory interpretation and implementation guidance, environmental restoration, environmental community relations, and hazardous waste management in support of the Laboratory's programs. EPD prepares and maintains environmental plans, reports, and permits; maintains the environmental portions of the *ES&H Manual*; informs management about pending changes in environmental regulations pertinent to LLNL; represents the Laboratory in day-to-day interactions with regulatory agencies and the public; and assesses the effectiveness of pollution control programs.

EPD monitors air, sewerable water, groundwater, surface water, soil, sediments, vegetation, and foodstuff, as well as direct radiation; evaluates possible contaminant sources; and models the impact of LLNL operations on humans and the environment. In 2000, 13,483 samples were taken, and 260,158 analytes were tested. The type of samples collected at a specific location depends

on the site and the potential pollutants to be monitored; see the specific chapters of this report for discussions of each environmental medium.

A principal part of EPD's mission is to work with LLNL programs to ensure that operations are conducted in a manner that limits environmental impacts and is in compliance with regulatory guidelines. EPD helps LLNL programs manage and minimize hazardous, radioactive, and mixed wastes; determines the concentrations of environmental contaminants remaining from past activities; cleans up environmental contamination to acceptable standards; responds to emergencies in order to minimize and assess any impact on the environment and the public; and provides training programs to improve the ability of LLNL employees to comply with environmental regulations.

LLNL programs are supported by the Hazards Control Department's five ES&H teams and by EPD's five environmental support teams (ESTs). The ESTs are integrated into the ES&H teams through environmental analysts, who also chair the ESTs. Each EST includes representatives from environmental specialties within the Operations and Regulatory Affairs Division (ORAD), the ES&H teams, and a field technician from the Hazardous Waste Management (HWM) Division. Some ESTs also include a representative from the Environmental Restoration Division (ERD) or the organizations supported by the ESTs. These teams evaluate operations, determine potential environmental impacts, and provide guidance on environmental regulations and applicable DOE orders for existing and proposed projects. ESTs assist programs in planning, implementing, and operating projects and in understanding and meeting their environmental obligations. When permits are obtained from regulatory agencies, ESTs aid the programs in evaluating the permit conditions and implementing requirements.



Operations and Regulatory Affairs Division

ORAD currently consists of seven groups that specialize in environmental compliance and monitoring and provide Laboratory programs with a wide range of information, data, and guidance to make more informed environmental decisions.

ORAD prepares the environmental permit applications and related documents for submittal to federal, state, and local agencies; provides the liaison between LLNL and regulatory agencies conducting inspections; tracks chemical inventories; prepares National Environmental Policy Act (NEPA) documents; conducts related field studies for DOE; oversees wetland protection and floodplain management requirements; coordinates cultural and wildlife resource protection and management; facilitates and provides support for the pollution prevention and recycling programs; teaches environmental training courses; coordinates the tank environmental compliance program; conducts compliance and surveillance monitoring; and provides environmental impact modeling and analysis, risk assessment, and reporting.

ORAD also actively assists in responding to environmental emergencies such as spills. During normal working hours, an environmental analyst from the ORAD Environmental Operations Group (EOG) responds to environmental emergencies and notifies a specially trained environmental duty officer. Environmental duty officers are on duty 24 hours a day, 7 days a week, and coordinate emergency response with LLNL's ES&H team and other first responders or environmental specialists.

Hazardous Waste Management Division

All hazardous, radioactive, and mixed wastes generated at LLNL facilities are managed by the HWM

Division in accordance with state and federal requirements. HWM processes, stores, packages, solidifies, treats, and prepares waste for shipment and disposal, recycling, or discharge to the sanitary sewer.

As part of its waste management activities, HWM tracks and documents the movement of hazardous, mixed, and radioactive wastes from waste accumulation areas (WAAs) located near the waste generator to final disposition; develops and implements approved standard operating procedures; decontaminates LLNL equipment; ensures that containers for shipment of waste meet the specifications of the U.S. Department of Transportation (DOT) and other regulatory agencies; responds to emergencies; and participates in the cleanup of potential hazardous and radioactive spills at LLNL facilities. HWM prepares numerous reports, including the annual and biennial hazardous waste reports required by the state and federal environmental protection agencies (see Appendix C). HWM also prepares waste acceptance criteria documents, safety analysis reports, and various waste guidance and management plans.

HWM meets regulations requiring the treatment and disposal of LLNL's mixed waste in accordance with the requirements of the Federal Facility Compliance Act. The schedule for this treatment is negotiated with the State of California and involves developing new on-site treatment options as well as finding off-site alternatives.

HWM is responsible for implementing a program directed at eliminating the backlog of legacy waste (waste that is not at present certified for disposal). This effort includes a large characterization effort to identify all components of the waste and a certification effort that will provide appropriate documentation for the disposal site.

Environmental Restoration Division

ERD was established to evaluate and remediate soil and groundwater contaminated by past hazardous materials handling and disposal processes and from leaks and spills that have occurred at the Livermore site and Site 300, both prior to and during LLNL operations. ERD conducts field investigations at both the Livermore site and Site 300 to characterize the existence, extent, and impact of contamination. ERD evaluates and develops various remediation technologies, makes recommendations, and implements actions for site restoration. ERD is responsible for managing remedial activities, such as soil removal and groundwater extraction, and for assisting in closing inactive facilities in a manner designed to prevent environmental contamination.

As part of its responsibility for Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) compliance issues, ERD plans, directs, and conducts assessments to determine both the impact of past releases on the environment and the restoration activities needed to reduce contaminant concentrations to protect human health and the environment. ERD interacts with the community on these issues through Environmental Community Relations. Public meetings are held each year and information is provided to the public as required in the ERD CERCLA Community Relations Plans. To comply with CERCLA groundwater remedial actions at the Livermore site, ERD has to date designed, constructed, and operated five fixed groundwater treatment facilities and associated pipeline networks and wells, 19 portable groundwater treatment units, two catalytic dehalogenation units, and two soil vapor extraction facilities (see Chapter 8). ERD also installed an electroosmosis system to improve our ability to remove contaminants from fine grained sediments. At Site 300, ERD has designed, constructed, and operated three soil

vapor extraction facilities and eleven groundwater extraction and treatment facilities. In addition, ERD has capped and closed four landfills and the High Explosives Rinse Water Lagoons and Burn Pits, excavated and closed numerous waste water disposal sumps, and removed contaminated waste and soil to prevent further impacts to groundwater at Site 300.

ERD is actively designing, testing, and applying innovative remediation and assessment technologies to contaminant problems at the Livermore site and Site 300. ERD provides the sampling and data management support for groundwater surveillance and compliance monitoring activities.

Environmental Training

The LLNL Environmental Protection Training Program (EPTP) provides Laboratory workers the appropriate training support to assure that they have the knowledge, skills, and abilities to competently, safely, and effectively carry out the job-related environmental protection responsibilities of their work assignments. In 2000, EPTP provided nearly 10,000 hours of environmental protection training to over 3,100 Laboratory workers involved in science related work at LLNL. EPTP also provided over 3,000 additional hours of specialized training to LLNL environmental professionals involved with activities related to the management of waste and other environmental protection activities. The environmental training developed and delivered to our Laboratory workers during 2000 addressed the requirements of the National Environmental Policy Act, the Resource Conservation and Recovery Act, the Superfund Amendment and Reauthorization Act, the Occupational Safety and Health Administration and other Federal and California State regulatory requirements. Training subjects included hazardous waste management, low-level waste generation and certification, transuranic waste generation and certification, spill



prevention, control, and countermeasures, and other similar environmental protection related topics. The EPTP staff is supported in the development and delivery of training by environmental protection subject matter experts (SMEs) from the three EPD divisions. In close coordination, the divisions provide the assessment and interpretation of training to be given to Laboratory workers and to internal Department environmental protection specialists. In addition, the divisions supply SMEs and personnel who are trained and qualified to be instructors for the EPTP. The EPTP staff consists of technical and administrative personnel familiar with the various environmental regulations and requirements and cognizant in Laboratory operations requiring environmental protection training.

Performance Measures Summary

Since 1992, UC's contract to manage and operate LLNL for DOE has contained performance objectives, criteria, and measures. Four of these performance measures (PMs) are used to evaluate LLNL's environmental protection activities.

At the end of 2000, DOE gave LLNL an average score of excellent for its environmental performance in FY2000. DOE scores for individual performance measures are shown in **Table 3-1**. Performance measure data for FY2000 will be included in the annual self-assessment and evaluation conducted in 2001.

Table 3-1. UC Contract 48 environmental protection performance measures for environmental performance in FY2000

PM designator	Performance measure	Location in <i>Environmental Report</i>	Score
1.2.b	Radiation dose to the public Public radiation doses to the maximally exposed individual from DOE operations will be measured or calculated and controlled to ensure that doses are kept as low as reasonably achievable (ALARA).	<i>Environmental Report 1999 and Environmental Report 2000</i> : Chapter 13, Radiological Dose Assessment, section on Radiological Doses to the Public from LLNL Operations. Chapter 2, Compliance Summary, section on National Emission Standards for Hazardous Air Pollutants.	Outstanding
1.2.g	Process and solid waste generation (Waste reduction and recycling) The Laboratory continues to progress toward meeting the DOE pollution prevention goal for the year 2005.	<i>Environmental Report 1999 and Environmental Report 2000</i> : Chapter 3, Environmental Program Information, section on Waste Minimization/Pollution Prevention.	Outstanding
1.2.h	Environmental violations The rate of validated environmental violations, determined from inspections and reporting requirements from regulatory agencies is kept low.	<i>Environmental Report 1999</i> : Chapter 2, Compliance Summary, Tables 2-5 and 2-9 <i>Environmental Report 2000</i> : Chapter 2, Compliance Summary, Tables 2-5 and 2-10	Excellent
1.2.i	Environmental releases The Laboratory controls and reduces the number of occurrences of environmental releases and the number of releases that result in violations.	<i>Environmental Report 1999</i> : Chapter 2, Compliance Summary, Table 2-9 . <i>Environmental Report 2000</i> : Chapter 2, Compliance Summary, Table 2-10 .	Outstanding

DOE Pollution Prevention Goals

In a memo dated November 12, 1999, the Secretary of Energy issued a new and challenging set of pollution prevention and energy efficiency (P2/E2) goals for the DOE Complex in response to the President's Executive Orders for Greening the Federal Government. The DOE P2/E2 Leadership goals, presented in **Table 3-2** have expanded the scope of the P2 goals in place during the 1990s by including the following: building and facility energy efficiency; reduction of releases of toxic chemicals, ozone-depleting substances, and greenhouse gases; increased vehicle fleet efficiency and use of alternative fuels; and the required purchasing of environmentally preferable products and services. The new P2/E2 goals continue to use 1993 as a baseline and have interim measurement points in 2005 and 2010.

The DOE P2/E2 Leadership Goals are intended to be achieved on a Department-wide basis. DOE field offices, such as the Oakland Field Office are responsible for developing and incorporating appropriately adapted goals for each of their sites into annual performance agreements for each site. For LLNL, past DOE P2 goals were reflected in UC Contract performance measure 1.2.g. However, the new P2/E2 goals have not yet been formally incorporated into LLNL performance measures.

Pollution Prevention Reporting

Typically LLNL has prepared a P2 Plan to meet the requirements of (1) DOE Orders 435.1 and 5400.1; (2) Resource Conservation and Recovery Act of 1976 (RCRA) Sections 3002(b) and 3005(h); and (3) Title 22 of the California Code of Regulations. This plan, updated every three years, has reviewed past and current pollution prevention activities and defined the objectives of LLNL's waste minimization and pollution prevention

efforts. The plan was last updated and submitted to DOE in May 1997 (Celeste 1997). While preparation of an update was expected in 2000, the timeline was deferred per DOE guidance. During the latter half of 2000, LLNL P2 personnel focused efforts on a different report, the *LLNL Report on Pollution Prevention and Energy Efficiency Leadership Goals*. Due for completion and submission to DOE in early 2001, this report provides information on how LLNL intends to accomplish the new DOE P2/E2 goals. It is expected that this report will take the place of the usual triennial P2 Plan.

LLNL is required by UC Contract performance measure 1.2.g to annually review its waste generation in terms of pollution prevention opportunities and to propose implementation projects. During 2000, the LLNL P2 staff prepared the *1999 Comprehensive Opportunity Assessment for Pollution Prevention, Energy Efficiency, and Water Conservation at Lawrence Livermore National Laboratory, Livermore Site* (PRAG 2001). The report identified and cataloged opportunities for pollution prevention throughout the Livermore site using fiscal year 1999 data from routinely generated hazardous, mixed, and radioactive waste; non-hazardous solid waste; and industrial solid waste databases. The report recorded previously evaluated alternatives and current or planned programs for particular waste streams and potential projects in the energy efficiency and water conservation areas. It differed from the previous *1997 Comprehensive Opportunity Assessment* (Celeste 1997) report by reviewing only current routinely generated wastes.

Waste Minimization/Pollution Prevention

The P2 Program at LLNL strives to systematically reduce solid, hazardous, radioactive, and mixed-waste generation and eliminate or minimize pollutant releases to all environmental media from all aspects of the site's operations. These efforts

**Table 3-2. Pollution Prevention and Energy Efficiency Leadership Goals at Department of Energy Facilities**

Goal ^(a)	Detail
Reduce Waste and Recycling	Reduce waste from routine operations by 2005, using a 1993 baseline, for these waste types: Hazardous by 90% Low Level Radioactive by 80% Low Level-Mixed Radioactive by 80% Transuranic (TRU) by 80%
	Reduce releases of toxic chemicals subject to Toxic Chemical Release Inventory reporting by 90% by 2005, using a 1993 baseline.
	Reduce sanitary waste from routine operations by 75% by 2005 and 80% by 2010, using a 1993 baseline.
	Recycle 45% of sanitary wastes from all operations by 2005 and 50% by 2010.
	Reduce waste resulting from cleanup, stabilization, and decommissioning activities by 10% on an annual basis.
Buy Items with Recycled Content	Increase purchases of EPA-designated items with recycled content to 100%, except when not available competitively at reasonable price or that do not meet performance standards.
Improve Energy Usage	Reduce energy consumption through life-cycle cost effective measures by: 40% by 2005 and 45% by 2010 per gross square foot for buildings, using a 1985 baseline 20% by 2005 and 30% by 2010 per gross square foot, or per other unit as applicable, for laboratory and industrial facilities, using a 1990 baseline.
	Increase the purchase of electricity from clean energy sources: (a) Increase purchase of electricity from renewable energy sources by including provisions for such purchase as a component of our requests for bids in 100% of all future DOE competitive solicitations for electricity. (b) Increase the purchase of electricity from less greenhouse gas-intensive sources including but not limited to new advanced technology fossil energy systems, hydroelectric, and other highly efficient generating technologies.
Reduce Ozone Depleting Substances and Greenhouse Gases	Retrofit or replace 100% of chillers greater than 150 tons of cooling capacity and manufactured before 1984 that use class I refrigerants by 2005.
	Eliminate use of class I ozone depleting substances by 2010, to the extent economically practicable, and to the extent that safe alternative chemicals are available for DOE class I applications.
	Reduce greenhouse gas emissions attributed to facility energy use through life-cycle cost-effective measures by 25% by 2005 and 30% by 2010, using 1990 as a baseline.
Increase Vehicle Fleet Efficiency and Use of Alternative Fuels	Reduce our entire fleet's annual petroleum consumption by at least 20% by 2005 in comparison to 1999, including improving the fuel economy of new light duty vehicle acquisitions and by other means.
	Acquire each year at least 75% of light duty vehicles as alternative fuel vehicles, in accordance with the requirements of the Energy Policy Act of 1992.
	Increase usage rate of alternative fuel in departmental alternative fuel vehicles to 75% by 2005 and 90% by 2010 in areas where alternative fuel infrastructure is available.

a From DOE P2/E2 leadership goals, dated November 12, 1999

help protect public health and the environment by reducing or eliminating waste management and compliance costs, improving resource usage, reducing inventories and releases of hazardous chemicals, and minimizing civil and criminal liabilities under environmental laws. In accordance with EPA guidelines and DOE policy, the P2 Program uses a hierarchical approach to waste reduction (i.e., source elimination or reduction, material substitution, reuse and recycling, and treatment and disposal) applied where feasible to all types of waste.

The P2 staff tracks waste generation using the HWM Division's Total Waste Management System (TWMS) database.

By reviewing this database, the P2 staff can identify waste streams with potential problems for each directorate and address issues in a timely manner.

Routine waste generation by waste category, from 1993 through 2000, is shown in **Table 3-3**. The trend from 1993 on shows a dramatic reduction in all waste categories, which is the result of LLNL's proactive P2 program.

Table 3-4 presents the percent reductions in routine waste generation for 2000 compared with the 1993 baseline. With the decreases in routine radioactive and hazardous waste generation, the Laboratory met the UC Contract performance measures goal of 50% in 1997. Current reductions are 78% and 66% respectively. The 50% reduction goal for low-level mixed waste was achieved in 2000, largely because of an improved treatment technology and a decrease in programmatic generation. Reduction of the sanitary waste stream from the baseline of 1993 is currently at 19%. Further discussion of the sanitary waste stream occurs in the following section.

Table 3-3. Routine waste generation totals (tons), 1993–2000

Waste category	1993 ^(a) (baseline)	CY1994	CY1995	CY1996	CY1997	CY1998	CY1999	FY2000 ^(b)
Low-level radioactive	256	181	136	91	68	73	66	56
Low-level mixed	34	26	36	23	21	25	20	14
Hazardous	628	510	368	360	240	232	188	212
Sanitary	2600	2246	2246	2001	2017	2201	2210	2103
LLNL totals	3518	2963	2786	2475	2346	2531	2484	2385

a Baseline values 1993 through 1997 adjusted per agreement between DOE/OAK and LLNL on February 20, 1998

b In 2000 the format for reporting waste generation for UC Contract performance measures changed from a calendar year (CY) to a fiscal year (FY) basis. To keep numbers consistent with the published performance measures, FY waste generation is reported for 2000.

**Table 3-4. Routine waste reduction, 2000**

Waste category	Reduction 2000 vs. 1993 (%)
Radioactive	78
Mixed	59
Hazardous	66
Sanitary	19

Nonhazardous Solid Waste Minimization

In 2000, LLNL sent 4605 tons of routine and nonroutine, nonhazardous waste (also designated as sanitary waste) to a landfill. The routine portion was 2096 tons and the nonroutine portion was 2509 tons. The breakdown for routine and nonroutine waste is shown in **Table 3-5**.

Table 3-5. Total nonhazardous waste sent to landfills, 2000

Nonhazardous waste	2000 total (tons)
Routine	
Compacted	1828
Industrial (TWMS) ^(a)	268
Routine subtotal	2096
Nonroutine	
Construction demonstration (noncompacted)	2363
Industrial (TWMS)	146
Nonroutine subtotal	2509
LLNL total	4605

^a TWMS = Total Waste Management System

Diverted Waste

The total waste diverted from landfills in 2000 was 26,563 tons (see **Table 3-6**). This 2000 relative decrease in total diversions with respect to previous years was due to a decreased quantity of soil leaving the site.

Table 3-6. Diverted waste totals, 1996–2000

Date	Diverted waste totals (tons)
1996	20,266
1997	323,465 ^(a)
1998	31,513
1999	47,161.5
2000	26,563

^a The 1997 solid waste diversion total of 323,465 reflects an increase in soil reuse, predominately driven by construction of the National Ignition Facility.

Table 3-7 shows a breakdown of waste diversion categories for 2000, reflecting the variety of diversion programs in place at LLNL. Soil, a major contributor to diversion totals, is reused both on site and at the landfill for daily cover. Asphalt and concrete are reused as road base material at the landfill. Wood waste, created by broken pallets, shipping crates, and demolition or construction scrap, cannot be cost-effectively reused on site, so it is gathered in a collection yard for recycling by a vendor at a cost lower than that of other disposal alternatives. Intact pallets and other reusable wood remain on site for internal reuse.

Composting landscape clippings from the site's lawns, trees, shrubs, and annual plantings is another waste reduction method. Once it is properly aged, the compost is used on site as a soil amendment. By generating its own soil builders, LLNL benefits twice: by eliminating an organic waste stream (with no tipping fees or hauling required), and by saving the purchase cost of new material. In one activity that both reduces waste and helps conserve water, gardeners chip office Christmas trees at the end of the holiday season to create mulch that is used year-round, reducing the amount of dry-season irrigation necessary in tree wells.

Table 3-7. Diverted waste summary, 2000

Waste description	Cumulative 2000 total (tons)
Asphalt/concrete	3,872
Batteries	48
Cardboard	186
Compost	513
Cooking grease/food	4.5
Diverted soil	19,476
HWM recycled materials	178
Magazines, newspapers, and phone books	22
Metals	1,504
Paper	310
Tires and scrap	30
Toner cartridges	2
Wood	402
Beverage containers	15
LLNL diversion total	26,563

Another well-developed and highly visible component of the LLNL recycling effort is the office-paper collection and reclamation project. The Laboratory operates a full-site program, with more than 122 facility collection points. Unclassified paper is transported to a contract firm, where it is shredded and recycled into toilet paper and egg cartons. Classified paper is preprocessed at the Livermore site using a hammer mill destruction process. Additionally, LLNL collects and recycles external and internal phone books, newspapers, and magazines by placing recycling bins on site for pickup by a local vendor. If a recycling bin is not easily accessible, employees may also mail these items to a central collection point. These items would otherwise contribute to the solid waste stream.

LLNL continues to look for diversion opportunities. A beverage container recycling program initiated in late 1999 was increasingly successful in 2000. This program, which serves all three on-site cafeterias, collected 15 tons of aluminum, glass, and plastic containers and steel food cans, which were taken off site for recycling by a local vendor.

According to its management contract with UC, LLNL's goal was to reduce the generation of routine sanitary (nonhazardous) waste by 33% by December 31, 1999. As shown in **Table 3-5**, after recycling, LLNL generated 2096 tons of routine nonhazardous waste in 2000, a reduction of 19% with respect to the baseline. Because the 33% reduction goal has not yet been achieved, despite an impressive 85% recycling rate for nonhazardous waste, the Laboratory has a strong incentive to continue to identify new nonhazardous-waste reduction measures. The *LLNL Report on Pollution Prevention and Energy Efficiency Leadership Goals* discusses several ideas that could help LLNL in this effort. The most ambitious ideas involve the design, building, and operation of an onsite Materials Recovery Facility (MRF). At MRF, LLNL's commingled solid-waste stream would be manually sorted, increasing the diversion of recyclable and reusable materials. Given the cost, building an MRF will be possible only if specific funding for this project is received from DOE.

Cities and counties have been required by California law to reduce nonhazardous solid waste by 25% and 50% between the baseline year of 1990, and 1995 and 2000, respectively. LLNL contributes to this effort by tracking and reporting its waste diversions to the County of Alameda. Significant reductions have been achieved. Compared with the 1990 baseline, by 1995 LLNL reduced its nonhazardous waste by 46% (see **Table 3-8**), which compared favorably with unincorporated



Table 3-8. Nonhazardous solid waste summary, 1990–2000

	1990	1995	2000
Nonhazardous solid waste (routine and nonroutine) (tons)	8332 ^(a)	4560	4605
Percent reduction	NA	46%	45%

^a The 1990 baseline weight is an estimated figure. A conversion factor was used to convert the recorded volume of land-filled waste to a weight value. LLNL waste was not weighed at the landfill until 1994.

Alameda County (8.9% reduction) and the City of Livermore (13.8% reduction) for 1995. Additional details are discussed in *Assessing the Nonhazardous Solid Waste Stream at Lawrence Livermore National Laboratory* (Wilson 1999). Generating a total of 4605 tons in 2000, LLNL's 45% nonhazardous waste reduction remains fairly consistent with the 1995 reduction.

Source Reduction and Pollution Prevention

LLNL P2 staff continue to survey on-site operations for opportunities to eliminate, reduce, recover, or recycle potential pollutants to all media, including air, water, soil, sediments, and biota.

Toxic Reporting Inventory Information

The Reporting Year 1999 Toxic Reporting Inventory (TRI) FORM R Report for Freon 113 (1,1,2-trichloro-1,2,2-trifluoroethane, also known as CFC 113) was submitted to the Department of Energy on June 21, 2000. All other chemicals are present in quantities below the threshold reporting levels or are in a form that does not require reporting.

Freon 113, which is used in parts cleaning operations and as a coolant or refrigerant, is an ozone-depleting substance whose consumption and production are slated for elimination by the year 2000. For this reason, the replacement and recycling of Freon 113 is a high priority at LLNL.

During 2000, LLNL decreased its inventory of Freon 113 as equipment from the Atomic Vapor Laser Isotope Separation (AVLIS) program was decommissioned.

Current Return-on-Investment Projects

The DOE funds P2 projects through the High-Return-on-Investment (ROI) P2 Program. LLNL prepared and received funding for two high ROI P2 project proposals in 2000. The two high ROI projects that received funding and began in 2000 are listed in **Table 3-9**. Also listed is an on-going project funded in 1999.

Table 3-9. High return-on-investment projects, 2000

Operation	Project
Conversion from aerosol to aqueous brake cleaning at LLNL auto maintenance facilities	This project funded the conversion from the use of solvent aerosol spray cans for brake cleaning to an aqueous system in two LLNL automotive facilities.
LLNL Fuel Incentive Program	To promote use of car- and vanpooling by LLNL commuters, this project provided the startup costs for a program giving registered vanpool and carpool drivers the opportunity to purchase discounted gas for their pool vehicles at the Lab's two fuel stations.
Low-Hg Fluorescent Lighting Pilot at LBNL and LLNL	This project studies the benefits and drawbacks of converting to low-Hg fluorescent tubes in office and shop space (It received funding in 1999. Work on this ROI project was ongoing in 2000.)

Review of New Processes or Experiments

Many organizations at LLNL use a "front-end" review process that applies to new programs, projects, or experiments that could have a significant impact on the environment. In this review,

hazardous materials projected to be used are identified and wastes expected to be generated are estimated. The possibilities for chemical substitution, process changes, and recycling are then addressed. If an opportunity for P2 is identified, the Pollution Prevention staff assists the generator in evaluating the options. Researchers and project managers are encouraged to implement reasonable P2 opportunities that have been identified.

Design for Environment

Design for environment is a concept that involves developing an understanding of potential environmental impacts over the lifetime of a project, with the goal of minimizing or mitigating those potential impacts through modifications to the project at the design stage.

In 1997, the Pollution Prevention Team and National Ignition Facility (NIF) project management completed a design-for-environment evaluation of the opportunities within the NIF project. Based on this evaluation, the laboratory implemented recycling programs during NIF construction, prepared a Pollution Prevention Plan for NIF, and implemented aqueous cleaning concepts in the design for parts and optics cleaning. The *NIF Pollution Prevention and Waste Minimization Plan* (Cantwell and Celeste 1998), which was completed in 1998, included pollution prevention opportunity assessments (PPOAs) on the predicted waste streams identified in the preliminary environmental impact statement. In 2000, a follow up document was completed, the *NIF Pollution Prevention and Waste Minimization 2000 Supplement*, which updated the PPOAs as needed, accounting for two years of design progress and process development. This work continues with the aim of developing and implementing waste minimization options before NIF becomes operational.

Implementing P2 Employee Training and Awareness Programs

General P2 awareness for LLNL employees is promoted through new employee training and orientation, posters, articles in *Newsline* (LLNL's weekly newspaper), and administrative briefings and memos. The Pollution Prevention Team also sponsors a yearly Earth Expo event open to employees, their families, and the local community to provide awareness of environmentally sound technologies and LLNL waste diversion initiatives. P2 information directed at technical employees is found in LLNL's *ES&H Manual* (Volume III, Part 7), is covered in the EPD training course *Hazardous Waste Generation and Certification*. This information is also disseminated to employees by means of organizing conferences and workshops, and making formal presentations to groups such as the ES&H Working Group's Environmental Subcommittee.

ChemTrack

ChemTrack, which is a computerized chemical inventory system, serves as an important tool for ensuring that LLNL complies with the Superfund Amendment and Reauthorization Act (SARA) Title III and California Business Plan reporting requirements and for improving the overall management of hazardous materials. ChemTrack enhances LLNL's ability to obtain the toxic release information necessary to complete SARA 313 submittals, to improve emergency response capabilities and management of material safety data sheets (MSDSs), to more closely track specific high-hazard chemicals and other regulated substances, and to screen selected LLNL facilities for preliminary hazard analyses. ChemTrack currently contains records of approximately 178,000 chemical containers ranging from 210-L drums to gram-quantity vials.



Current Issues and Actions

Many current issues and actions are described in this report according to chapter subjects. This section lists several not covered elsewhere.

Leaking Underground Fuel Tank Studies

As part of continuing state-funded leaking underground fuel tank (LUFT) studies, LLNL is continuing to work with the California State Water Resources Control Board (SWRCB) to identify groundwater resources that may be vulnerable to methyl tertiary-butyl ether (MTBE) impact. As part of this effort, LLNL has developed a pilot geographic information system (GIS) to assess the vulnerability of public drinking water sources from fuel hydrocarbon releases, including MTBE, and assist in managing the public risk that may be associated with these releases. The working pilot GIS, called GeoTracker, can be viewed at: <http://geotracker.llnl.gov>.

GeoTracker gives users the ability to assess potential threats to their drinking water sources. It determines the distance between contaminant sites and sensitive drinking water sources. The tools built into GeoTracker can quickly identify and display the number of LUFT sites within various distances of wells. Further, a set of on-line tools allows the user to integrate well-specific and contaminant site-specific information to give users the potential to analyze various aspects of vulnerability.

Evaluation of the Use of Ethanol to Replace MTBE in Gasoline

On March 25, 1999, California Governor Gray Davis issued Executive Order D-5-99, calling for the removal of MTBE from gasoline at the earliest

possible date but no later than December 31, 2002. To assist the SWRCB, LLNL has led a team of researchers in evaluating the potential groundwater and surface water impacts that may occur if ethanol is used to replace MTBE. These findings are reported in *Health and Environmental Assessment of the Use of Ethanol as a Fuel Oxygenate* (Rice and Cannon 1999). This document has been presented to the California Environmental Policy Council and can be viewed at: <http://www-erd.llnl.gov/ethanol/>.

The presence of ethanol in groundwater may alter microbially mediated benzene, toluene, ethylbenzene and xylene (BTEX) fate and transport processes and could contribute to increased benzene plume lengths. Several abiotic and biotic processes or mechanisms that affect the fate of ethanol and ethanol-gasolines in the subsurface are continuing to be studied by LLNL.

During evaluation of groundwater and surface-water impacts, LLNL began to develop a comprehensive life-cycle model. Work continued on a life-cycle model that systematically addresses impacts from fugitive and accidental releases associated with the production, distribution, and use of ethanol-containing gasoline. LLNL also continued to examine the salient environmental properties of alkylates, which are nonoxygenated compounds likely to be used in greater amounts in gasoline after MTBE is phased out.

Several modeling efforts evaluating the behavior of benzene groundwater plumes in the presence of ethanol indicate that benzene plumes are likely to increase in length, but the amount of this increase is not well known. A number of recommendations have been made to address knowledge gaps in the potential groundwater and surface-water impacts associated with using ethanol to replace MTBE.

Initiative to Improve Volatile Organic Compound Cleanup Process by Using Historical Case Analysis

The goal of this initiative is to evaluate a large number of nationwide historical cases to identify common volatile organic compound (VOC) release conditions that pose low risks and can be managed with minimal effort and cost, versus release conditions that pose higher risks and warrant larger expenditures. The key to this initiative is a cross-cutting evaluation of the large amount of VOC case data that is available.

This study is ongoing, and LLNL is continuing to gather chlorinated VOC historical case data to improve the evaluation of the behavior of chlorinated VOC plumes. A Phase 1 final report, entitled, *Historical Case Analysis of Chlorinated Volatile Organic Compound Plumes* (McNab et al. 1999), has been completed and can be viewed on the Internet at: <http://www-erd.llnl.gov/library/AR-133361.html>.

Nuclear Regulatory Commission

Since the spring of 2000, the Operations and Regulatory Affairs Division (ORAD) has been providing technical assistance to the Nuclear Regulatory Commission (NRC). Much of ORAD's work is in preparing NRC staff for responding to license renewal requests due from more than 100 US nuclear power plant operators in 2006, and in preparing the extensive NEPA documentation to support its decisions.

ORAD staff also leads a team of experienced LLNL staff in supporting NRC in a variety of activities, including participating in planning processes and public interactions, developing leaders from LLNL staff to manage NRC technical support, and providing expertise to NRC in preserving natural resources and addressing environmental policy issues.

ORAD also supports NRC in programs at LLNL, such as assisting in the maintenance and updating of an existing Geographical, Environmental & Siting Information system, a project managed within NRC's contract with the Fission Energy and Systems Safety Program (FESSP) at LLNL.

University of California, Merced

LLNL is supporting the new University of California campus at Merced (UCM), which is scheduled to open for students in 2004, by helping UCM solidify its commitment to building a strong environmental program and protecting its sensitive natural resources. Through several programs, such as Partnerships for the Future, LLNL is helping UCM strengthen its research, teaching and outreach mission in the Central Valley and support its research programs that will focus on critical issues such as population growth and development impacts in California.

EPD, along with counterparts from Lawrence Berkeley and Los Alamos National Laboratory, will also be assisting UCM in several areas of environmental responsibility. These include advising in permitting and building design, identifying best management practices for sensitive wetlands habitat, and providing expertise and assessments on specific subjects of environmental concern.

International Projects

Morocco

EPD has provided support to Morocco's National Center for Nuclear Energy Sciences and Techniques (CNESTEN), as part of a Sister Lab Agreement between the United States and the government of Morocco. CNESTEN has consulted EPD about several areas of environmental monitoring and management, such as the development of analysis reports, waste management, environmental monitoring and modeling,



and in the identification of salinity sources and their impact on drinking water resources.

Former Soviet Union/International Science Centers

EPD personnel are supporting U.S. non-proliferation and arms control programs by participating in environmental projects sponsored by two nonproliferation research centers in the former Soviet Union. These two centers, the International Science and Technology Center (ISTC) in Moscow and Science and Technology Center of Ukraine (STCU) in Kiev, sponsor development of novel environmental technologies that are an important component in the conversion of former Soviet scientists from weapons to nonweapons work.

By participating as auditors and collaborators, the EPD team has had the opportunity to review environmental monitoring, restoration, and waste management projects that may lead to unique solutions to environmental problems in the former Soviet Union and elsewhere. In addition, EPD has recognized a potential for applying the principles of these projects to EPD missions.

Response to Spills and Other Environmental Emergencies

All spills and leaks (releases) at LLNL that are potentially hazardous to the environment are investigated and evaluated. The release response process includes identifying the release, shutting off the source (if it is safe to do so), eliminating ignition sources, contacting appropriate emergency personnel, cordoning off the area containing the released material, absorbing and neutralizing the released material, assisting in cleanup, determining if a release must be reported to regulatory agencies, and verifying that cleanup (including decontaminating and replenishing spill equipment) is

complete. Environmental analysts provide guidance to the programs on preventing spill recurrence.

To maximize efficient and effective emergency environmental response, EPD established a 7-day-a-week, 24-hour-a-day, on-call rotational position entitled the environmental duty officer (EDO). Specialized EDO training includes simulated incidents to provide the response personnel with the experience of working together to mitigate an environmental emergency, determine any reporting requirements to regulatory agencies and DOE, and resolve environmental and regulatory issues within the LLNL emergency response organization. The on-duty EDO can be reached by pager or cellular phone at any time.

During normal work hours, Laboratory employees report all environmental incidents to the Environmental Operations Group (EOG) environmental analyst assigned to support their program area. The EOG environmental analyst then notifies the on-duty EDO of the incident, and together they determine applicable reporting requirements to local, state, and federal regulatory agencies and to DOE. The EDO and the EOG environmental analyst also notify and consult with program management and have 7-day-a-week, 24-hour-a-day access to the office of Laboratory Counsel for questions concerning regulatory reporting requirements.

During off hours, Laboratory employees report all environmental incidents to the Fire Dispatcher, who, in turn, notifies the EDO and the Fire Department, if required. The EDO then calls out additional EPD support to the incident scene as necessary, and follows the same procedures as outlined above for normal work hours.

LLNL's Other Environmental Programs

While EPD plays a central role, every directorate at LLNL is responsible for environmental compliance and minimizing the impacts of its operations. Several directorates have taken particularly noteworthy steps in this direction. Some examples include the plans for Defense Nuclear Technologies Program's Contained Firing Facility at Site 300 that will move explosive tests inside a facility where the debris is contained, the Laser Program's efforts to design the National Ignition Facility to have minimal environmental impact, Engineering's Metal Finishing Group's continuing efforts to reduce waste and substitute less hazardous chemicals in many of its processes, and the Education Program's efforts to enhance environmental education. Additionally, general waste minimization and pollution activities have been integral to the overall Defense Programs Directorate.

Integral to LLNL's environmental efforts is the ongoing research and development activities of the Energy and Environmental Programs Directorate. This directorate conducts multidisciplinary research to assess and mitigate environmental and human risk from natural and man-made hazards and to develop and demonstrate new tools and technologies for environmental restoration. This work primarily involves state of the art ground-water modeling and advanced hydrogeologic tracer studies; in situ environmental remediation using natural and engineered processes; pathway, dosimetry, and risk analysis of radioactive and toxic substances; atmospheric dispersion modeling and dynamics; subsurface imaging and characterization; and seismic processes.

Contributing Authors Acknowledgment

Major contributors to this diverse chapter were Mo Bissani, Winifred A. Burks-Houck, Katharine Gabor, Charlene Grandfield, Steve Harris, C. Susi Jackson, Paula Kato, Saverio Mancieri, Barbara Nisbet, Ellen Raber, David Rice, George Sanford, Kris Surano, Charlotte van Warmerdam, Joseph Woods, and Kenneth Zahn.